

Abnormal electron heating by magnetic filter field in a negative hydrogen ion source

June Young Kim,¹ Won-Hwi Cho,¹ Jeong-Jeung Dang,¹ Kyoung-Jae Chung,² and Y. S. Hwang^{1*}

¹*Department of Nuclear Engineering, Seoul National University, Seoul, South Korea*

²*SNU Division of Graduate Education for Sustainable Foundation Energy, Seoul National University, Seoul, South Korea*

Abnormal heating of the electrons near RF antenna (driver region) is observed with magnetic filter near the extraction region in the planar type inductively coupled H⁻ ion source. Axial profile of plasma parameters are measured with an RF compensated Langmuir probe from the driver region to the extraction region. Axial variations of the electron density and the temperature near the extraction region at low pressure show great agreement with previous results [1]. However, the electron temperature significantly changes near the driver region at low pressure discharge in the presence of filter field. The abrupt variation of the electron temperature is analyzed with the consideration of two components of magnetic filter fields (parallel and perpendicular to axial direction in the cylindrical source chamber). It is believed that the electron cyclotron resonance (ECR) heating near 4.8 G (axial magnetic field) may occur as electron heating near the driver region at low pressure of 3 mTorr. At relatively higher pressure of 20 mTorr, the ECR effect disappears due to the increased electron-neutral collision frequency, and the experimental results well follows the previous result [1]. Although electron cooling effect via filtering of high energy electrons has been considered as a main effect of the magnetic filter in the negative hydrogen ion source, appropriate level of the axial component of the magnetic filter field at low pressure may contribute to increase electron temperature significantly in the driving region. As a desire to develop high performance negative ion source, the increased electron temperature through the ECR effect with optimized filter field configuration may give another path to enhance the efficiency of the negative ion source.

[1] A. Aanesland, J. Bredin, P. Chabert, and V. A. Godyak, Appl. Phys. Lett. 100, 044102 (2012)